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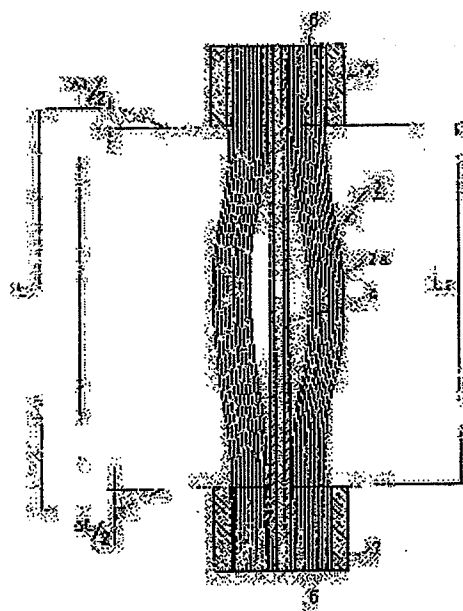(22)Date of filing :   08.12.1986

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(54) HOLLOW YARN MEMBRANE FILTER

(57)Abstract:

PURPOSE: To prevent the damage of a hollow yarn and to perform effective backwashing, by a method wherein hollow yarns are arranged so that the length of each of the hollow yarns between both adhesive filling parts is so excessive as to satisfy a specific condition with respect to the interval between both adhesive filling parts.

CONSTITUTION: In a hollow yarn membrane filter 2, the length $L1$ of each of the hollow yarns 2a arranged in a slightly loosened state between upper and lower end adhesive filling parts 6 is set so that an excessive length ΔL satisfies the relation $0.01 \leq \Delta L/L1 \leq 0.04$ (wherein $\Delta L = L1 - L2$) with respect to the distance $L2$ between both adhesive filling parts 6. By this method, the whirling-up of the hollow yarns 2a at the time of backwashing and the accompanying entanglement, bending or breakage can be prevented and, since the hollow yarns 2a are shaken properly, effective backwashing can be performed. Further, a solid component released at the time of backwashing is not accumulated in the hollow yarn membrane filter 2. Furthermore, a liquid effectively flows around the hollow yarns 2a positioned at a central part at the time of filtering.

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(54) Title of Invention: Hollow Yarn Membrane Filter

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                         Specification

1. Title of the Invention

       Hollow yarn membrane filter

2. Claims

       In the context of a hollow yarn membrane filter in which multiple pieces of
hollow yarn are bundled, filling and securing with bonding agent are performed in such a

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way that both bundled ends open, a bundle securing member is installed and secured at the outer circumference of the bonding agent filling sections filled with the aforesaid bonding agent, and the aforesaid bonding agent filling sections at both ends are connected across a specified length; a hollow yarn membrane filter characterized in that the length (L1) of the hollow yarn between the aforesaid two bonding agent filling sections is set so that there is a specified excess length (ΔL) with respect to the gap (L2) between the aforesaid two bonding agent filling sections, and this excess length (ΔL) satisfies the following conditions:

$$0.01 \leq (\Delta L / L1) \leq 0.04$$

where,

L1: The length of the hollow yarn arranged between the two bonding agent filling sections
L2: The gap between the two bonding agent filling sections
ΔL: (L1 - L2)

3. Detailed Explanation of the Invention

Objective of the Invention

Industrial Field of Usage

The present invention relates to a hollow yarn membrane filter used in water treatment apparatuses in various types of plants with the objective of separating and eliminating solid portions in the liquid to be treated.

Conventional Art

In general, the hollow yarn is a membrane of hollow cylindrical fiber which has small holes on its surface and whose outer diameter is approximately 0.3–3 mm. Therefore, it has benefits in that the filtration area per unit capacity is large, and pressure resistance is good. A filter is formed by bundling many pieces of the hollow yarn and hardening both ends with resin, which is a bonding agent. This hollow yarn membrane filter is used as a filtration device for water treatment apparatuses.

The structure of this type of hollow yarn membrane filtration device will be explained below while referring to Figure 5. Figure 5 is a cross-sectional diagram of a hollow yarn membrane filtration device, where callout 1 in the diagram is the container main unit. The interior of this container main unit 1 is split into top and bottom by a diaphragm 3, where the lower space is a filtration chamber 1a, and the upper space is a processing fluid chamber 1b. The hollow yarn membrane filter 2 is hanging down from the aforesaid diaphragm 3 within the aforesaid filtration chamber 1a. The aforesaid

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hollow yarn membrane filter 2 has a structure whereby multiple pieces of hollow yarn 2a are bundled at the outer circumference of a support member 4, and their upper and lower ends are secured by bonding agent filling sections 6, and, in addition, bundle securing members 7 are installed and secured from the outer circumferences thereof. Also, in the apparatus shown in Figure 1, the hollow yarn membrane filter 2 with the aforesaid configuration is connected in two stages in a perpendicular direction, where callout 8 in the diagram is the connecting tube which is used when this is done. A fluid supply pipe 10 which connects with the filtration chamber 1a is connected to the lower end of the aforesaid container main unit 1 while a processing fluid discharge pipe 11 which connects with the processing fluid chamber 1b is connected to the upper end. A shut-off valve 12 is positioned along the aforesaid fluid supply pipe 10, and a concentrated fluid discharge pipe 13 is branch connected. A shut-off valve 14 is positioned along this concentrated fluid discharge pipe 13. The fluid which has been supplied to the interior of the filtration chamber 1a via the aforesaid fluid supply pipe 10 is filtered when it passes through the hollow yarn membrane filter 2, and it is discharged via the hollow sections of the respective pieces of hollow yarn 2a.

In the aforesaid configuration, when the differential pressure before and after the hollow yarn membrane filter 2 rises due to filtration and reaches a specified value, a backwash operation is executed to perform an operation to wash off the solid portion which has adhered to the surfaces of the respective pieces of hollow yarn 2a. That is, a pressurized gas for backwashing is supplied inside the respective pieces of hollow yarn 2a of the hollow yarn membrane filter 2 via the aforesaid processing fluid discharge pipe 11. Simultaneously, a bubbling operation is executed from below the hollow yarn membrane filter 2. That is, a bubbling pipe 15 is arranged below the hollow yarn membrane filter 2 within the aforesaid container main unit 1, and bubble holes 16 are formed in the lower surface of this bubbling pipe 15. The aforesaid bubbling pipe 15 is connected to an air supply pipe 17 which has a shut-off valve 18. By supplying air to the aforesaid bubbling pipe 15 via the aforesaid air supply pipe 17, bubbles are generated from the aforesaid bubble holes 16. The hollow yarn membrane filter 2 is subject to bubbling by the aforesaid bubbles to improve the washing effect. An overflow pipe 19 is connected to the container main unit 1 so that it is positioned below the aforesaid diaphragm 3, and a shut-off valve 20 is positioned along said overflow pipe 19. Callout 21 in the diagram is a protecting tube, and this protecting tube 21 which allows the bubbles from the aforesaid bubbling to be effectively introduced into the hollow yarn membrane filter 2.

The current situation is such that, when backwashing is performed on a hollow yarn membrane filter 2 with the aforesaid configuration, the question of what degree of excess length should be set for the length (L1; a value larger than L2, since there is some looseness in the gap which is the aforesaid L2) of the hollow yarn 2a arranged between the two ends with respect to the distance (shown by callout L2 in Figure 5) between the two ends, which was determined according to the bonding agent filling sections 6 at both ends, in order to effectively perform the aforesaid bubbling and prevent damage to the hollow yarn 2a has not been taken into account. Conventionally, it has been set with

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excess length of approximately 5 percent. However, situations in which the multiple pieces of hollow yarn 2a become twisted then bent and damage have occurred as filtration and backwashing were repeated. This is thought to be because the hollow yarn 2a consists of a polymeric material, and its specific gravity is almost equal to that of water, which is the main constituent of the processed fluid, so the hollow yarn 2a whirls up, then bends and becomes damaged. As a means of solving these types of problems, the excess length, which has been set to approximately 5 percent as mentioned above, may be shortened or eliminated. However, the following problems occur when such a method is adopted.

1) First, when the range of oscillation of the hollow yarn 2a when the aforesaid bubbling is performed is restricted more than is necessary, it is impossible to obtain a sufficient bubbling effect.

2) When the hollow yarn membrane filter 2 is bundled in the aforesaid way in a condition in which multiple pieces of hollow yarn 2a are densely arranged, and the excess length is decreased, the effects are such that the fluid to be processed does not flow efficiently between the respective pieces of hollow yarn 2a, and, therefore, only the hollow yarn 2a which is positioned at the outer circumference of the hollow yarn membrane filter 2 is provided for filtration. This is also undesirable from the standpoint of filtration efficiency, and it results in a phenomenon by which solid portion adheres only to the hollow yarn 2a positioned at the outer circumference.

3) Also, when backwashing is executed, there is a problem in that the solid portion which has been separated by said backwashing accumulates among the pieces of hollow yarn 2a, and removal of the separated solid portion is not performed effectively. This is because, ultimately, the flow characteristics among the pieces of hollow yarn 2a are poor because the hollow yarn 2a is densely arranged in the same way as the aforementioned 2), and the excess length is short.

Problems To Be Solved By the Invention

In this way, in conventional hollow yarn membrane filters, there has not been sufficient study with respect to how to determine the excess length, resulting in various problems. The present invention was designed taking these points into account, and its objective is to provide a hollow yarn membrane filter equipped with an excess length which makes it possible to perform effective backwashing while preventing damage to the hollow yarn.

Configuration of the Invention

Means To Solve Problems

In the context of a hollow yarn membrane filter in which multiple pieces of hollow yarn are bundled, filling and securing with bonding agent are performed in such a way that both bundled ends open, a bundle securing member is installed and secured at

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the outer circumference of the bonding agent filling sections filled with the aforesaid bonding agent, and the aforesaid bonding agent filling sections at both ends are connected across a specified length; the hollow yarn membrane filter of the present invention is characterized in that the length (L1) of the hollow yarn between the aforesaid two bonding agent filling sections is set so that there is a specified excess length (ΔL) with respect to the gap (L2) between the aforesaid two bonding agent filling sections, and this excess length (ΔL) satisfies the following conditions:

$$0.01 \leq (\Delta L/L1) \leq 0.04$$

where,

L1: The length of the hollow yarn arranged between the two bonding agent filling sections
L2: The gap between the two bonding agent filling sections
ΔL: (L1 - L2)

Action

Setting the excess length of the hollow yarn within the aforesaid range effectively solves such problems as the drop in the backwashing effect which occurs due to the excess length being too small as it eliminates the bending and damage which result from the twisting of the hollow yarn which occurs due to the excess length being too great.

Embodiments

An embodiment of the present invention will be explained while referring to Figures 1 through 4. The same portions as in the conventional example are indicated by the same callouts, and explanations of these portions have been omitted. Figure 1 is cross-sectional diagram of the configuration of the hollow yarn membrane filter 2, where the length (L1) of the hollow yarn 2a arranged between the two bonding agent filling sections 6 at the top and bottom ends in a condition which is somewhat loosened has an excess length (ΔL) with respect to the distance (L2) between the aforesaid two bonding agent filling sections 6, and this excess length (ΔL) is set within the following range. $0.01 \leq (\Delta L/L1) \leq 0.04 \dots (I)$

where,

L1: The length of the hollow yarn arranged between the two bonding agent filling sections
L2: The gap between the two bonding agent filling sections
ΔL: (L1 - L2)

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The reason that the excess length (ΔL) is set within this range is to effectively eliminate both the harmful effects resulting from the excess length being too great and the harmful effects resulting from the excess length being too small, which will be explained below while referring to Figures 3 and 4.

Figure 3 shows the proportion (%) of the excess length (ΔL) with respect to the length (L1) of the hollow yarn 2a on the horizontal axis and the number of bent sections of the hollow yarn 2a (among 1,000 pieces of yarn) on the vertical axis. According to this diagram, when the proportion of the excess length (ΔL) with respect to the length (L1) of the hollow yarn 2a is 4 or less, the number of pieces of hollow yarn 2a in which bent sections have occurred is extremely small. Therefore, if the excess length (ΔL) proportion is set to 4 or less, it is possible to effectively eliminate harmful effects resulting from the excess length being large. The lower limit value will be explained while referring to Figure 4. Figure 4 shows the proportion (%) of the excess length (ΔL) with respect to the length (L1) of the hollow yarn 2a on the horizontal axis and the backwashing efficiency (solid portion volume separated by backwashing /captured solid portion volume, %) on the vertical axis. As we can see from Figure 4, when the proportion of the excess length (ΔL) with respect to the length (L1) of the hollow yarn 2a is 1 or less, backwash efficiency quickly deteriorates. As shown in Figure 2, this is because it is necessary for the hollow yarn 2a to oscillate to certain extent when bubbling is performed during backwashing, and the solid portion gets shaken off by said oscillation. Moreover, the following has been observed. Because movement of the hollow yarn 2a is limited more than is necessary when the excess length (ΔL) proportion has been set to less than 1, filtrate does not flow in the vicinity of the hollow yarn 2a of the center section of the hollow yarn membrane filter 2, resulting in only the outer circumference portion of the hollow yarn 2a being provided for filtration. This may be observed from the fact that the solid portion only adheres to the hollow yarn 2a positioned at the outer circumference. It has also been confirmed that when a setting of less than 1 is used simultaneously with this, the solid portion which has been separated during backwashing flows into the hollow yarn membrane filter 2 and cannot be effectively removed. For this reason, the proportion of the excess length (ΔL) with respect to the length (L1) of the hollow yarn 2a has been given a lower limit value of 1.

The above embodiment is able to exhibit the following benefits.

1) First, it is possible to effectively prevent the situation whereby the hollow yarn 2a whirls up during backwashing and therefore becomes twisted and bent or damaged.

2) Also, effective backwashing becomes possible due to the hollow yarn 2a oscillating to an appropriate degree during backwashing.

3) In addition, the solid portion separated during backwashing does not flow into the hollow yarn membrane filter 2.

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4) Also, filtrate flows efficiently even around the hollow yarn 2a positioned at the center section of the hollow yarn membrane filter 2 even during filtration, so it is possible to prevent the situation whereby filtration is only performed at the outer circumference section and to provide effective filtration.

Benefits of the Invention

As explained in detail above, through the hollow yarn membrane filter resulting from the present invention, there are great benefits in that it is possible to prevent the situation whereby the hollow yarn whirls up and therefore becomes twisted and bent or damaged and to provide effective backwashing.

4. Brief Explanation of the Figures

Figures 1 through 4 are diagrams which show an embodiment of the present invention, where Figure 1 is a front view of a hollow yarn membrane filter; Figure 2 is a front view of a hollow yarn membrane filter which shows the action during backwashing; Figure 3 is a characteristics diagram which shows changes in the number of pieces in which bent sections occur when the excess length of the hollow yarn is changed; Figure 4 is a characteristics diagram which shows changes in the backwashing effect when the excess length of the hollow yarn is changed; and Figure 5 is a cross-sectional diagram of a hollow yarn membrane filtration apparatus.

2	Hollow yarn membrane filter
2a	Hollow yarn
4	Support member
6	Bonding agent filling section
7	Bundle securing member

Figure 1

Figure 2

1.   Air

Figure 3

1.

The number of pieces of hollow yarn in which bent sections occur (per 1,000 pieces of hollow yarn) (pieces)

2.

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The proportion of excess length (ΔL) with respect to the length L2 of the hollow yarn (%).

Figure 4

3.

Backwashing efficiency (solid portion volume separated by backwashing/captured solid portion volume) (%)

4.

The proportion of excess length (ΔL) with respect to the length L2 of the hollow yarn

Figure 5

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